# EFFECT OF EPOXY RESIN AS PARTIAL CEMENT REPLACEMENT ON COMPRESSIVE STRENGTH AND TENSILE STRENGTH WITH THE FIXED PROPORTION OF SILICA SAND AS PARTIAL SAND REPLACEMENT

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I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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# ABSTAK

Struktur adalah elemen yang dapat dijumpai di setiap negara. Kebanyakan struktur disokong oleh unsur-unsur yang dibuat oleh konkrit seperti rasuk, lajur, papak dan asas. Ia memainkan peranan penting dalam menahan beban dari elemen atas yang meningkatkan kestabilan dan ketahanan struktur. Bahan utama yang digunakan dalam campuran untuk menghasilkan konkrit adalah simen. Karbon dioksida telah dikeluarkan dalam proses pengeluaran simen. Apabila pembangunan negara meningkat, liputan kawasan bandar meningkat dan penggunaan simen telah meningkat. Oleh itu, usaha untuk mengkaji kesan resin epoksi sebagai pengganti simen separa dalam konkrit pada kekuatan mampatan dann kekuatan tegangan adalah amat penting. 30 bilangan sampel konkrit telah disediakan untuk tujuan kerja makmal. Ujian kekuatan manpatan dan ujian kekuatan tegangan digunakan untuk menentukan kekuatan mampatan dan tegangan bagi setiap sempel untuk mendapatkan peratus optimum simen boleh digantikan dengan resin epoksi untuk menghasilkan kekuatan optimum. Dalam kajian ini, 30% simen yang digantikan dengan resin epoksi memberikan kekuatan mampatan optimum serta kekuatan tegangan berbanding 10% dan 20% sampel. Keputusan kekuatan mampatan yang direkodkan dari kajian ini berbeza dari 5.96 hingga 2917 MPa manakala hasil kekuatan tegangan yang direkodkan berubah dari 1.26 hingga 2.23 MPa. Hasil keseluruhan sampel menunjukkan berkadar terus apabila peratusan resin epoksi meningkat.

## ABSTRACT

Structures are the elements that can be found in every country. Most of the structures are supported by the elements that made by concrete such as beam, column, slab and foundation. It play an important roles in withstand the loads from the upper elements which increase the stability and durability of the structures. The main material used in the mixtures to produce concrete is cement. The carbon dioxide was emitted in the process of cement production. As the development of the country increased, the coverage of urban area was increased. Hence, the usage of cement was increased. Therefore, making an effort to study the effect of the epoxy resin as the partial cement replacement in concrete on compressive strength and tensile strength is crucial. 30 numbers of concrete samples were prepared for the purpose of laboratory works. Compressive strength test and tensile strength test were used to determine the Compressive Strength and tensile strength of each sample in order to observe the optimum percentage of cement can be replace by epoxy resin to produce optimum strength. In this research, the 30% of cement was replaced by the epoxy resin gave the optimum compressive strength as well as tensile strength compare to 10% and 20% of the samples. The results of compressive strength recorded from this research varied from 5.96 to 29.17 MPa while the results of tensile strength recorded were varied from 1.26 to 2.23 MPa. The overall results of the samples show directly proportional when the percentage of the epoxy resin increased.

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# LIST OF SYMBOLS

| | |
|---|---|
| MPa | Mega Pascal |
| mm | Millimetre |
| KN | Kilonewton |
| m | metre |
| Kg | Kilogram |
| g | Gram |
| $M^3$ | Metre Cube |
| g/mol | Gram per moles |
| °C | Degree Calcius |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ASTM | American Section of the International Association for Testing Materials |
| PIC | Polymer Impregnated Concrete |
| PMC | Polymer Modified Concrete |
| PC | Polymer Concrete |
| IPCC | Intergovernmental Panel on Climate Change |
| CAS | Chemical Abstract Service |
| UTM | Universal Testing Machine |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of study

Nowadays, concrete has been widely used in the field of construction as supporting material to transfer the load of the building. Therefore, concrete is an important material in construction project. As we know that concrete is the combination of cement, coarse and fine aggregates. Cement act as the binder that bind the aggregate to produce significant strength. However, cement brings negative impact to the environment. The manufacturing of cement is not environmental friendly due to the emission of carbon dioxide, nitrogen monoxide, sulphur dioxide, volatile organic compounds and others especially during the production of clinker in calcination process. The emission can also be in form of dust, noise and vibration during the operation of machineries. Although many machinery has been invented to overcome the problems of emission however the elimination of harmful substance due to emission still cannot be totally prevented. Other than that, there is another weakness of concrete is it is with poor tensile and flexural strength, high porosity and low resistant toward the chemicals substance.

As a result, polymer cement concrete is under research for the replacement of cement. In polymer cement concrete, polymer act as the binder between the aggregate instead of cement in order to improve its properties. The polymer cement concrete has more excellent properties compare to the concrete. Besides that, it is much more environmental friendly compare to cement. The environment pollution cause by the manufacturing of cement can be solved with the replacement of cement with epoxy resin to act as the aggregate binder. There are various polymers that can choose to

replace cement as the binder in the concrete. Epoxy resins are one of the syntactic polymers that can replace cement as the binder and it has better properties than the cement. In the addition, epoxy modified concrete has good resistance toward heat, strong resistance to the acid, organic solvents.

Epoxy resin manufacture from the petroleum derived and some plant derived sources also can produce the resin. For this research, Epoxy resins are purchased from the supplier. Cured Epoxy has excellent properties which are high resistance to acids, alkali and heat. The fine aggregate of the polymer concrete also replace by the silica sand which is almost same size with the sand. This is to reduce the void ratio during the mixing process. By using silica sand as the fine aggregate the minimum void ratio between the epoxy, cement and aggregate is decrease and this can improve the strength of the concrete.

Due to the advantages of epoxy resin instead of the cement and replacement by the silica powder instead of sand as the fine aggregates, thus in this research the different proportion ratio of epoxy resin studied to examine the compressive strength and the best model also been determined.

## 1.2 Problem Statement

In this twenty-first century, all the countries are in the state of development which means that the ratio of the building to the natural has been increase. The emission of air pollutants will increase while those countries are in the developing process. Global warming is one of the most serious problems that concern by the public and government. This is because the global warming can cause negative effect to our next generation if global warming is more serious sea level will also increase. The main air pollutant which causes global warming is greenhouse gas which also called carbon dioxide. In our knowledge, plants inhale in carbon dioxide and manufacture their food under the process of photosynthesis and thus in the same time this action has kept the planet cool. However, by increasing the manufacturing of concrete of combination of cement, course and fine aggregates will cause rising of carbon dioxide level which will then turn the cooling system down. According to research study of (“Carbon dioxide’s effects on plants increase global warming, study finds -- ScienceDaily”,

2010) global warming cause by the greenhouse gas and the increase of carbon dioxide would cause significant warming to the planet which then will cause the melting of the iceberg, the climatic change and flash flood.

All of us know that concrete is the common component use in civil engineering construction field as the support element to transfer the load to earth. Meanwhile, cement is the main component to act as the binder between the aggregate to form concrete. However, the manufacture process of cement will emit large amount of carbon dioxide gas and significant amount of solid waste materials that will cause environment pollution. Furthermore, according to the Earth Institute of Columbia University the industries which produce a material so ubiquitous and invisible is cement which caused global warming (Ebnesajjad, 2016). https://chemical-materials.elsevier.com/new-materials-applications/global-warming-carbon-dioxide-buildings-and-clt/ Thus, in this research, different portion of the epoxy resin to replace cement with the fix portion of sand replace with the silica sand is investigated to determine the optimum portion which can achieve the largest strength. By doing so, the best portion of epoxy resin can be found and in same time help to reduce the use of cement in the construction field and cut down the side effect toward environment.

### 1.3 Objective

The main aim of this research is to investigate the optimum proportion of cement can replace by the epoxy resin in order to increase the mechanical properties of concrete. The objectives of this study are:

1. To study the effect of the epoxy resin as the partial cement replacement in concrete on compressive strength with the optimum proportion of silica sand as the partial sand replacement.
2. To study the effect of the epoxy resin as the partial cement replacement in concrete on tensile strength with the optimum proportion of silica sand as the partial sand replacement.

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